Impact of Infrastructure Investment on Economic Growth in Nigeria: An Autoregressive Distributed Lag Approach

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Abstract: **This study examined the relationship between government spending on economic infrastructure and economic growth in Nigeria from 1989 to 2018. Real gross domestic product was used to proxy economic growth and was specified as a function of government spending on transport and communication, government spending on power and employment rate (as a proxy for the classical theory of labour force).The Autoregressive Distributed Lag Bounds method to co-integration was chosen to ascertain the impact and the long-run relationship between the dependent and independent variables. The short-run and long-run results showed that government spending on power exerted a positive but insignificant effect on Nigeria's RGDP. However, government spending on transport and communication had a positive relationship in the short-run but negative relationship in the long-run. Furthermore, the Causality results showed a uni-directional causality running from RGDP to GEXP and EMP to GEXTC but there was no evidence to support the existence of causality between the remaining pairs of variable. It is recommended that in order for Nigeria to achieve infrastructure development success, it is important that the government redirect excessive revenue in the maintenance of government official to these pivotal sectors of the economy with a view to monitoring the implementation after disbursing funds to the affected ones to subsequently trigger economic growth.**

Keywords**: Economic infrastructure, Economic growth, Co-integration, ARDL, Nigeria.**

I. INTRODUCTION

Adequate supply of infrastructure facilities has long been recognized by academics, policymakers and researchers not only as an important economic facilitator, but also as the backbone of economic growth and development activities for many industrialized countries (William, 2016; Orji and Worika, 2017; Ogbaro and Omotoso, 2017). Infrastructure plays a very important role in the growth process of an economy. In fact development economist have considered infrastructure to be a pre-condition for take-off into self-sustained growth (Rostow, 1960). Infrastructure refers to the basic physical and organizational structures needed for the operations of a society. It is broadly divided into two categories: economic and social. Economic infrastructure facilitates economic production and helps to produce items that are consumed by households. It includes transport, communication, power generation, water supply and sanitation facilities. Social infrastructure has a direct and an indirect impact on the quality of life, examples, educational, health-care and recreational facilities.

Core economic infrastructure in the areas of transport, energy, and communication has always played important roles in maintaining economic performance. In fact, these infrastructural facilities are an important input in a nation's production function and it has major implication for the attainment of 2030 sustainable economic growth policy. It contributes to economic growth by increasing productivity, lower unit cost of production and enhances the quality of life. In the opinion of Nworji and Oluwalaiye (2012), increased government investment on infrastructural sectors such as transport, power, communication, water and housing will enhance reduction in the production costs, stimulate private sector investment and profit margin of firms, create increased employment and wealth and also provide essential services to citizens; thereby improving the growth of the economy. The World Economic Forum in its 2018 report estimates that every dollar spent on capital projects generates an economic return of 5%-25%, which will stimulate growth and development across all sectors in Nigeria. Investment on infrastructure is a capital- intensive project, which in most countries are largely publicly owned and regulated, and which also provides the backbone of the production and distribution system.

Nigeria is one of the most resource endowed nations in the world – natural resources, large market, and young population made it an attractive destination for private sector investment. Report has it that Nigeria ranked 13th largest oil producing country in the world. According to the Global Economy (2016), world ranking for oil rents placed Nigeria on the top 21st position and Nigeria also maintains the eighth position among the 15 countries that exported the highest value worth of crude oil in 2017. Expectations are that spin-off from oil over the years would trickle down into strong and viable infrastructure development. Ironically, Nigeria is considered a challenging place to do business because of the difficulties in accessing finance, and poor infrastructure, hence, ranked 169 out of 190 countries in the World Bank's 2018 Doing Business index. According to the 2019 World Bank's Enterprise survey that surveyed over 2,000 small businesses in Nigeria, the major obstacles faced by businesses are limited

access to finance, poor infrastructure (especially power and transport), foreign exchange difficulties and corruption. Poor or non-existent infrastructural facilities and the difficult business environment add to the cost of doing business and is a disincentive to domestic and foreign investors alike. This is a drawback to Nigeria economy. Available statistics from Nigeria Economic and Recovery Growth Plan 2017 showed that the total value of Nigeria's infrastructure stock (road, rail, power, airport, water, telecom and seaports) represents only 35% of GDP. This is far below the level of peer emerging market countries, where the value of infrastructure stock to GDP in Brazil, India, Indonesia, China, Poland and South Africa are 47%, 58%, 70%, 76%, 805 and 87% respectively.

Several countries of the global economy such as Japan, America, China and so on, without doubt, got to their level of economic growth and development based on the level of infrastructural development. The dreadful condition of most of the infrastructural facilities in Nigeria as well as their lack of maintenance has called the attention of the government over the years. Consequently, the Nigerian government has tried to increase expenditures in these sectors. Available statistics from Central Bank of Nigeria, 2020 showed that Federal Government expenditure on transportation increased from ₦202 billion in 2016, to ₦256 billion in 2017, to ₦278 billion in 2018, and latter fell to ₦133 billion in 2020. Similarly, expenditure on power sector which is fundamental to industrialization, economic growth and development increased from ₦272.43 billion in 2016 to ₦321.57 billion, and latter fell to ₦129.08 billion in 2020.

Report from CBN has it that from 2015 to date, over ₦1.114 trillion has been injected into infrastructural development in Nigeria. Yet, the country is still noted for her prevalence epileptic power supply, poor road network, absence of pipe-borne water, inadequate telecommunication services and general insecurity in the land which invariable have made it difficult for private sector investment in the country. The Federal government claimed that Nigeria loses over $29.3 billion yearly with attendant low capacity utilization among companies due to lack of power. Again, companies spend about 40% of their production cost on generating electricity for themselves and this lead to shutting operations of about 272 manufacturing firms in Nigeria in 2016. The resultant effects are high level of poverty rate and unemployment situation as many businesses close down and some relocated to other African countries. According to Iheanacho (2016), poor planning, corruption, mismanagement of fund, bureaucracy, foreign exchange fluctuations, insecurity and more are some factors affecting the development of infrastructure in Nigeria.

Since the late 1980s, academic interests in the role of public investment and economic growth have been revived. This was largely motivated by declines in public investment in the early 1970s and fall in economic productivity growth at roughly the same time. Arguments by Aschauer (1989) and others that there were significant linkages between economic growth and public infrastructure investments fueled the discussion. However, a number of studies that have been carried out on the effects of investment on infrastructure and economic growth in Nigeria: Nworji and Oluwalaiye (2012), Nedozi, Odasanmi and Ighata (2014), Osundina, Ebere and Osundina (2014) and Amadi and Alolote (2020) had concentrated on using the Ordinary Least Square (OLS) technique of estimation. This may not be good enough were data are basically not static as this results to biased and inconsistent estimates. Also, the long-run relationship could not be ascertained. More so, a recent study by Amadi and Alolote (2020) failed to carry out a causality test that is very crucial for policy formulation. In recognition of the gap created by the earlier studies, ARDL technique will be use in this study to arrest the disadvantage of the OLS thereby providing the analysis of the long-run relationship between investment on economic infrastructure and economic growth. Also, the study will employ the granger causality test to ascertain the course of causation between investments on economic infrastructure and economic growth in Nigeria.

In general the nexus between investments on economic infrastructure and economic growth remains unsettled and deserve further study. Against this backdrop, the aim of this study is to examine the impact of government spending on economic infrastructures and economic growth in Nigeria from 1989 to 2018 for better policy formulation and implementation. Specifically, the study will focus on the following objectives: to examine how government expenditure on transport and communication have contributed to Nigeria's economic growth within the period under review; to evaluate the contributions of government spending on power on the economic growth of Nigeria; to examine the influence of employment rate on the economic growth of Nigeria and to examine the causal link between infrastructure investment and economic growth in Nigeria. Consequently, the objectives necessitated these study questions: how has government expenditure on transport and communication contributed to Nigeria's economic growth within the period under review?; what really has been the contributions of government spending on power on the economic growth of Nigeria?; what is the level influence of employment rate on the economic growth of Nigeria?; and what is the direction of causality between infrastructure investment and economic growth in Nigeria?

The rest of this work is structured as follows: section two would focus on literature review and theoretical framework, section three describes data sources, methodology and model specification. Section four would concentrate on the presentation of data, analysis and discussion and lastly, section five concludes the work with conclusion and policy recommendations.

II. LITERATURE REVIEW

2.1. Empirical Literature

Various studies have been conducted to study the relationship between investment on infrastructure and economic growth.

The results of these studies vary from one to the other; owing to the difference in methodologies and time frames as well as the variables captured in the models. For instance, employing co-integration and error correction methods over the period of 1970 to 2008, Abu and Abdulhai (2010) investigated the relationship between government expenditure and economic growth in Nigeria. Their results reveal that government total capital expenditure, total recurrent expenditures, and government expenditure on education have negative effect on economic growth. On the contrary, rising government expenditure on transport and communication results to an increase in economic growth. In the same vein, Amassoma, Nwosa and Ajisafe (2011) assessed the linkage between components of government spending and economic growth in Nigeria using error correction model. Using components of government expenditure such as; agriculture, education, health, transport and communication, their results reviled that expenditure on agriculture had a significant effect on economic growth in Nigeria while expenditure on education, health and transport and communication had insignificant influence on economic growth. They recommended that, there is need for an increase in the budgetary allocation to the agricultural sector and also initiate incentives that can promote the activities of rural farmers in promoting output growth of the sector.

The study by Nworji and Oluwalaiye (2012) examined the impact of government spending on road infrastructure development on economic growth in Nigeria for the period 1980-2009. The model for the study was estimated using the Ordinary Least Square (OLS) technique. The result of the study shows that transport and communication, including defence, individually exerted statistically significant impact on the growth of the economy. The outcome also shows that the variables jointly exerted significant impact on the growth of the economy within the period under review. They therefore recommend that better co-ordination in terms of private participation in funding and maintenance of road infrastructure could further enhance the growth of the economy Similarly, Fasoranti (2012) examined the effect of government expenditure on infrastructure on the growth of Nigeria for 33 years from 1977 – 2009. The result reveals a long-run relationship between the explanatory variables and economic growth of Nigeria. Also, it was observed that government expenditures on health services, transport and communication impacted negatively on growth while expenditure in agriculture and security were not significant in the growth of the economy.

Utilizing the OLS over the period of 1970 to 2012, Osundina *et al*. (2014) investigated the relationship between government spending on infrastructure and poverty reduction in Nigeria. The results reveal that government spending on transportation, building and construction had a negative and positive effect respectively on poverty reduction in Nigeria and were significant, while the effect of government spending on education and health were insignificantly negative and positive respectively. Using co-integration and Vector Error Correction Mechanism approach (VECM), Edame, Udade and Ugwu (2014) examined the macroeconomic impact of public expenditure on infrastructure and economic growth in Nigeria from 1970 to 2006. They found that changes in rate of urbanization, openness, government revenue, external reserves, population density and type of government (administration), remarkably shaped growth on public expenditure in Nigeria in the short-run. On the contrary, the Vector Error Correction (VEC) showed that the level of public infrastructure (road construction, water supply, electricity supply, transport/telecommunication and housing/environment are very low in the short-run. The study recommended that government should adhered strictly on due process as a pre-condition for the released of funds for execution of contracts in the affected areas.

Equally, Nedozi *et al*. (2014) employed the Ordinary Least Square technique (OLS) to investigate infrastructural development and economic growth in Nigeria, using data sourced from CBN statistical bulletin from 1988 to 2013. The result of their finding shows that exchange rate, labour force, inflation rate and contribution of infrastructure to GDP jointly exhibits a significant positive relationship with economic growth in Nigeria. However, individually, exchange rate was not significant to Nigerian economic growth. It was recommended that since infrastructure is an intermediate goods and service for the real sector and a finished goods and service for consumers, it should be given qualitative and adequate attention so as to propel Nigerian growth and development.

Also, Charles, Onuchukwu and Tamuno (2018) examined the effect of government expenditure on construction, transport and communication in Nigeria from 1980 to 2016. Their study adopted the Engle- Granger Co-integration and Error Correction Modeling techniques for the analysis. The Engle-Granger co-integration test indicates that a long run relationship exists among the variables (i.e. government expenditure on construction, transport and communication and electricity availability and economic growth). Furthermore, the result revealed that both government expenditure on construction, transport and communication have a negative relationship with economic growth and also do not impact on it. Their paper recommended that the government should ensure that the construction, transport and communication sectors are adequately funded so as boost economic growth.

On the same subject, Ebuh, Ezike, Shitite, Smith and Haruna (2019), employed the Vector Error Correction Model (VECM) to investigate the nexus between infrastructure investment and economic growth in Nigeria, using quarterly data from 1997:Q1 to 2017:Q4. The findings showed that there is unidirectional causality relationship between income, financial infrastructure and infrastructure stock. Also, the results indicated a long-run link among the variables in the model. Total government spending on infrastructure, gross domestic capital formation, domestic credit to private sector, transport composite price index and domestic population

(human infrastructure) play a positive role in explaining the movement in the long-run aggregate income. They recommended that social planners should pay more attention to disaggregated analysis of infrastructure to better understand the spillover effects among various aspects of infrastructure and with the output growth in the long run and short run.

Amadi and Alolote (2020) carried out a research on Government Expenditure on Infrastructure as a Driver of Economic Growth in Nigeria, adopting the Weighted Least Square technique. Their result reveals that government spending on transport, communication, education and health infrastructure has significant effects on economic growth whereas, spending on agriculture and natural resources record a significant inverse effect on economic growth in Nigeria. The study recommends an increase in investment on the infrastructure that concerns agriculture so as to increase food supply. Also, the need for public enlightenment campaign to educate the public on the need to protect and maintain infrastructure provided by the government.

Similar studies have been conducted in some African countries. For South Africa, Akw Moeketsi (2017) investigated the relationship between road infrastructure investment and economic growth using annual data from 1960 to 2013, under the framework of Granger Causality and Vector Auto Regression (VAR). The study found a uni-directional causality running from economic growth to road infrastructure investment in South Africa. The VAR result indicated that road infrastructure investment, ICT stock and labour input had positive relation to economic growth. In another study that employed VECM, Mayekiso (2015) examined the impact of transport infrastructure investment on unemployment in South Africa using time series econometric analysis over the period 1982 to 2012. The study found that a long-run relationship exist between unemployment, transport infrastructure investment, real GDP, real exchange rate, real interest rate, trade openness and total infrastructure investment. However, Wainaina (2012) investigated the relation between telecommunication infrastructure and economic by analyzing the effects of interaction between mobile and landline teledensity, and their effects on economic growth for a sample of 44 Sub-Saharan Africa countries between 1998 to 2010. Using generalized method of moment, the study found out two way causality between mobile teledensity and economic growth while landline teledensity effect on economic growth is not vice versa.

Among the entire literature reviewed, it is generally clear that except the study by Nedozi *et al.* (2014), there is a dearth of research on the relationship between investment on core economic infrastructure and economic growth in Nigeria. However, they used wrong repressors (exchange rate, inflation rate and labour) to regress economic infrastructure. Our study is a departure from their study in the sense that we used disaggregated core economic infrastructures (transport, power, communication) to regress economic infrastructure. In addition to this, this study shall utilize the ARDL technique to account for the existence of endogenity in contrast to the study by Nedozi *et al.* (2014) which used the application of a single equation methodology like OLS. The ARDL approach permits the analysis of the long-run relationship between investment on economic infrastructure and economic growth. Furthermore, Amadi and Alolote (2020) failed to carry out a causality test that is very crucial for policy formulation.

In recognition of the gaps created in earlier studies through weakness of some of the approached employed and contradictions in the estimation, this study intends to fill these gaps by investigating the impact of investment on economic infrastructure on economic growth in Nigeria from 1989 to 2018 adopting the ARDL technique. The study also employed the granger causality test to ascertain the course of causation between investments on economic infrastructure and economic growth in Nigeria.

2.2. Theoretical Framework

This study is anchored on the unbalanced growth theory by Hirschman as it identifies the importance of investing into infrastructural development as important economic facilitator and the backbone of economic growth.

2.2.1. The Unbalanced Growth Theory

The guardians of the unbalanced growth theory include scholars like, Hirschman, Streeten, Fleming and Singer (1958). They promulgated the theory of unbalanced growth as a plan for development and growth to be used by underdeveloped countries. The theory emphasizes the need for investment in key strategic sectors of the economy rather than all the sectors simultaneously, for instance, investing into infrastructure development. Hirschman argued that creating imbalances in the system is the best strategy for growth. Stating further, he explained that owing to the lack of availability of resources in the less developed countries, the little that is available must be efficiently used.

If investment is carried out in the key sectors of the economy, the other sectors would automatically develop through what is known as "Linkage effect". This is possible by investing either in Social Overhead Capital (SOC) or Directly Productive Activities (DPA). Investments in social overhead capital are advocated not because of its direct effect on the final output, but it permits and invites DPA to come in as some SOC are required as a prerequisite of DPA investment. Social overhead capital has been defined as comprising those basic services without which primary, secondary, and tertiary productive activities cannot function. This includes in it the expenditure on roads, irrigation works, power, transport and communications. The investments on these projects create more economies and this is called divergent series of investment and is undertaken by public agencies. Whereas, Direct Productive Activities are those activities which are a consequence of some investment, add to the flow of final goods and services. It is called convergent series of investment because these project appropriate more economies

than they have created. These series of investments are undertaken by private entrepreneurs.

The strategy of unbalance growth suggests that since the underdeveloped countries cannot pursue a simultaneous investment in both SOC and DPA due to a general lack of resources so therefore they should according to Hirschman unbalance the economy for overall growth through SOC, as this would stimulate investment in DPA. In SOC are included investments on communication, transportation, power, education, public health, water, irrigation and drainage schemes etc. A large investment in SOC will encourage private investment later in Directly Productive Activities (DPA). For example, cheaper supply of electric power may encourage the establishment of small industries SOC investments indirectly subsidies agriculture, industry or commerce by cheapening various inputs which they use or by reducing their costs. Hirschman, Streeten, Fleming and Singer (1958) observes that, development has proceeded in this way with growth being transmitted from the key leading sectors (such as transport, power and communication) of the economy to other sub- sectors.

However, the core theoretical criticisms of the unbalanced growth theory among others is that it places too much emphasis on investment decisions while neglecting the relevance of administrative, managerial and policy decisions in developing countries. 'Unbalanced Growth Theory' assumes the availability of certain basic facilities in terms of necessary raw materials, technical knowhow and developed means of transport. However in less developed countries these are insufficient. Notwithstanding these criticisms, the unbalanced growth theory is still relevant in this study because it emphasizes investment on economic infrastructure as the backbone of economic growth.

III. METHODOLOGY

3.1. Data Sources

Annual time series data covering 1989 to 2018 were used to estimate the model. For this study, data will be collected on Real Gross Domestic product (RGDP) at 1990 and 2010 constant basic prices applied in (₦' Million) as proxy for economic growth; government spending on transport and communication (GEXTC in ₦' Million), government spending on power (GEXP in ₦' Million) and employment rate (EMP in percentage) as proxy for labour force. The data were obtained from Central Bank of Nigeria's Statistical Bulletin (various issues) 2014 and 2019 Editions respectively.

3.2. Model Specification

The model is built around the unbalanced growth theory that believes on unbalancing the economy for overall growth through SOC, as this would stimulate investment in DPA. Based on the unbalanced growth theory, investment on economic infrastructures will transmit growth to other sub-sectors of the economy through linkages effect. Following Nedozi *et al.* (2014) with some modifications, the model specification for this study is based on the Cobb-Douglas production function which is specified as follows:

$$Q = f(\beta K^{\infty}, L^{1-\infty}) \quad (1)$$

Where;

Q = aggregate real output (a proxy for economic growth)

β = efficiency of production

K = stock of capital

L = stock of labour

∞ and 1-∞ = output elasticities with respect to capital and labour respectively.

The model showed that output is determined by the productivity parameter of its inputs of labour and capital which necessitated the inclusion of government expenditure on economic infrastructures; this addition to the Cobb-Douglas production function is welcomed with a support by many economists like, (Waverman, Meloria and Melvyn, 2005). Higher public expenditure on economic infrastructure improves investment and hence, reduces cost of production, which leads to higher productivity and will bring about an increase in the value of economic growth. We consider government expenditure on transport and communication and government expenditure on power as Social Overhead Capital. However, considering Cobb-Douglas production function, it incorporates labour force as one of the most important variables for output. This is in conformity to economic postulation that more labour will lead to increased output. It is against this backdrop that we include employment rate in the model as control variable. This methodology will be used to estimate the impact of selected economic infrastructures (power, transportation and communication) and one macroeconomic variable (employment rate) (as proxy for labour force) on economic growth of Nigeria for the period of 1989-2018.

Therefore, the equation model adopted for this study is specified showing the functional relationship between the dependent and independent variables as follows:

$$RGDP = f(GEXTC, GEXP, EMP) \quad (2)$$

In order to take into consideration the influence of the stochastic or random variable, the equations are transformed as follows:

$$RGDP_t = a_0 + a_1 GEXTC_t + a_2 GEXP_t + a_3 EMP_t + U_t \quad (3)$$

However, because of highly skewed values, both the dependent and independent variables were logged. The logarithmic transformation was meant to transform them into a dataset that is normalized to avoid the problem of heteroscedasticity. Taking the natural log of equation (3), we have:

$\text{Log}(RGDP_t) = a_0 + a_1\text{Log}(GEXTC_t) + a_2\text{Log}(GEXP_t) + a_3\text{Log}(EMP_t) + U_t$ (4)

Where:

$RGDP_t$ = Log of real gross domestic product at time t

$GEXTC_t$ = Log of federal government spending on Transport and Communication at time t

$GEXP_t$= Log of federal Government spending on Power at time t

EMP_t = Log of Employment Rate at time t

a_0, = Intercept or constant coefficient

a_1,a_2, a_3= the parameters or coefficients to be estimated

U_t = Error term or stochastic variable accounting for other variables affecting the dependent variables (RGDP).

Apriori expectation:

In this model, the apriori expectation stipulates that a_1, a_2, $a_3 > 0$. That is all the variables of interest; government spending on transport and communication, power and employment rate is expected to have a positive relationship with the dependent variable which is economic growth (RGDP).

To capture our objective, this paper utilized the Auto-Regressive Distributed Lag (ARDL) Bounds testing approach developed by Pesaran, Shin, and Smith (2001) to investigate the impact of government investment on economic infrastructure to the growth of Nigerian economy. The justification for the selection of this approach is based on the advantages of the ARDL for testing the existence of a co-integrating relationship either in the short-run or long-run. The bound testing approach has certain econometric advantages in comparison to other single co-integration procedures (Engle and Granger, 1987; Johansen, 1988; Johansen and Juselius, 1990). First, it provides unbiased estimates of the long run model as well as valid t-statistics even when some of the regressors are endogenous. Secondly, the long-run and short-run parameters of the model in question are estimated simultaneously. Thirdly, the model yields consistent estimates of the long-run normal coefficients irrespective of whether the underlying regressors are stationary at 1(0) or at 1(1), or a mixture of both. In other words, it ignores the order of integration of the variables. Finally, the method yields results that are reliable in the case of small samples as argued in Narayan (2005). The model was estimated using the log values of the variables. The computation of the ARDL statistical procedure was done with version 9 of the E- views econometric software.

Equation (4) is formulated into the ARDL model as follows:

$$\Delta\log(RGDP_t) = a_0 + \sum_{j=0}^{k} a_{1j}\Delta\log(RGDP_{t-1}) + \sum_{j=0}^{k} a_{2j}\Delta\log(GEXTC_{t-1}) + \sum_{j=0}^{k} a_{3j}\Delta\log(GEXP_{t-1}) + \sum_{j=0}^{k} a_{4j}\Delta\log(EMP_{t-1}) + b_1\log(RGDP_{t-1}) + b_2\log(GEXTC_{t-1}) + b_3\log(GEXP_{t-1}) + b_4\log(EMP_{t-1}) + u_t \quad (5)$$

Where:

a_{1j} to a_{4j} = coefficients of the short-run parameters (where j=1,2…..n)

b_1 to b_4= coefficients of the long-run parameters

Δ= first difference operator

K = lag order selected by Akaike's Information Criterion (AIC)

t = time, t-1 =lag one (previous year)

μ_t = disturbance term

According to Pesaran et al. (2001), there are two procedures involved in estimating equation (5); the first step is testing for the long-run relationship and the next step is the estimation of long and short-run parameters using the OLS and Error Correction Model (ECM) respectively. In analyzing the result, we made use of critical value bounds of the F-statistic proposed by Pesaran et al. (2001) to ascertain the existence or absence of co-integration among the variables. In conducting the test, we compared the F-statistic with both the upper 1(1) and lower 1(0) critical values at the 5% level. The null and alternative hypotheses of absence and presence of long-run relationships between RGDP and its determinants (GEXTC, GEXP, and EMP) would be examined. The parameters are specified as:

$H_o = a_1 = a_2 = a_3 = 0$

against:

$H_A \neq a_1 \neq a_2 \neq a_3 \neq 0$

The condition is: if the computed F-statistic exceeds the upper critical bounds, the null hypothesis would be rejected implying that there is presence of a long-run relationship among the variables; but if the computed F-statistic lies below the lower critical bounds, the null hypothesis would be accepted, indicating that there is absence of co-integration. However, if the computed F-statistic falls between the lower and upper critical bound values, the result becomes inconclusive. Nevertheless, if the presence of co-integration was concluded among the variables in the model, the short-run and long-run parameters, depicting the short-run and long-run impacts of each variable on economic growth respectively would be evaluated. The long-run coefficients associated with the exogenous variables with fixed lags are estimated using the OLS, hence we have:

$$\log(RGDP_t) = a_0 + \sum_{j=0}^{k} a_{1j} \log(RGDP_{t-1}) + \sum_{j=0}^{k} a_{2j} \log(GEXTC_{t-1})$$

$$+ \sum_{j=0}^{k} a_{3j} \log(GEXP_{t-1}) + \sum_{j=0}^{k} a_{4j} \log(EMP_{t-1}) + \mu_t \text{ ----------(6)}$$

After examining the long-run estimates, the short-run coefficients would be examined by constructing an error correction model as depicted below:

$$\Delta\log(RGDP_t) = a_0 + \sum_{j=0}^{k} a_{1j} \Delta\log(RGDP_{t-1}) + \sum_{j=0}^{k} a_{2j} \Delta\log(GEXTC_{t-1})$$

$$+ \sum_{j=0}^{k} a_{3j} \Delta\log(GEXP_{t-1}) + \sum_{j=0}^{k} a_{4j} \Delta\log(EMP_{t-1}) + \Psi ECM_{t-1} + \mu_t, \text{ ----------(7)}$$

Here a_{1j} to a_{4j} are the coefficients of the short-run dynamics of the model's convergence to equilibrium while Ψ is the speed of adjustment which is anticipated to be negative and significant to verify the existence of co-integration among the variables and ECM_{t-1} is the error correction term. Other variables are as defined earlier.

IV. DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULT

4.1. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root Tests Results on Series

Before applying the ARDL bounds test, confirming the order of integration is a pre-requisite for almost all time series analysis. The rationale behind this is to avoid regressing non stationary variables which results to spurious regression results. In this study, testing for the stationarity of the variables, the techniques of Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests were employed to determine the degree of integration of the variables. The null hypothesis of no stationarity is tested at 5% critical value in a model with intercept and no trend. The null is accepted if the t-statistic is less than the critical value at the 5% level, otherwise it is rejected. Table (1) displays the summary of results of the unit root tests at levels and at first difference respectively.

Table1. ADF and PP unit root tests results.

Variable	**Augmented Dickey-Fuller (ADF)**				**Philip-Perron (PP)**			
	At level	1st difference	5% critical value	Order of Integration	At level	1st difference	5% critical Value	Order of Integration
LRGDP	-1.1923	-4.7888***	-2.9678	1(1)	-1.1847	-4.7888***	-2.9678	1(1)
LGEXTC	-2.9817*	-	-2.9678	1(0)	-2.9817*	-	-2.9678	1(0)
LEMP	-0.5081	-6.3815***	-2.9678	1(1)	-0.5081	-6.3815***	-2.9678	1(1)
LGEXP	-2.5591	-10.4514***	-2.9678	1(1)	-2.4015	-9.0222***	-2.9678	1(1)

Source: Authors Compilation (2021) using E-Views 9; Note: *** and * denotes statistical significance at 5% level of significance.

As depicted in table (1) above for the ADF and PP unit root tests, the results revealed that the variables were either 1(0) or 1(1). The variable (LGEXTC) was integrated at the level 1(0) whereas others (LRGDP, LEMP, LGEXP) were integrated at the first difference 1(1). This is because the ADF and PP statistics (in absolute terms) are greater than the Mackinnon critical values at 5% level of significance. Since the variables exhibited a mixture of 1(0) and 1(1), the usage of Autoregressive Distributed Lag (ARDL) Bounds test technique to co-integration recommended first by Pesaran and Shin (1999) and upheld by Pesaran *et al*. (2001) to estimate the parameters of the model is justified.

4.2. Result of the ARDL Bound Test for Co-integration

Having ascertained that the series are integrated of order zero 1(0) and order one I(1), we proceed to conduct a test for long-run relationship among the variables. The summary of the results of co-integration is displayed in table (2).

Table 2: Co-integration Results from Bound Tests

Test Statistic	Value	Lag	Significance level	Bound critical values	
				Lower Bound	Upper Bound
F-statistic	7.5599	4		1(0)	1(1)
			1%	4.29	5.61
			5%	3.23	4.35
			10%	2.72	3.77

Source: Author's Compilation (2021) using E-Views 9. Note: Lower and Upper Bounds critical values for the F-statistic at 5% level of significance was taken from Narayan (2005) and Pesaran (2001) and for this study, K which is the number of explanatory variables is 3.

The results in table (2) above show that the computed F-statistic is 7.5599 which is greater than the upper (4.35) critical value bound at all significance levels. Therefore, the null hypothesis of no co-integration between LRGDP and the explanatory variables in the model is rejected. The acceptance of the alternative hypothesis shows that a long-run relationship exists among the variables employed in the model at 5% significance level. Based on the result in Table 2 above, we conclude that there is strong support for a long-run relationship between infrastructure investment and economic growth in the model for Nigeria, hence the justification for the estimation of the long-run and short-run dynamic coefficient.

4.3. Long-Run Relationship Results

Table 3: Estimated Long-Run Coefficients Results

Dependent Variable: Log (RGDP)				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	17.796173	3.104019	5.733268*	0.0001
LEMP	-1.608974	0.549586	-2.927609**	0.0127
LGEXTC	-0.194119	0.035715	5.435261*	0.0002
LGEXP	0.069865	0.076616	0.911885	0.3798

Source: Summary of result compiled by authors (2021) using E-Views 9. Note * and ** denotes significance at 1% and 5% respectively.

The ARDL long-run results in Table 3 above show that government expenditure on power has a positive but insignificant impact on Nigeria's real gross domestic product. The result indicates that a unit increase in government spending on power will increase RGDP by 0.0698units. This result is in line with the theoretical expectation that an increase in government spending on power will lead to an increase in real gross domestic product in Nigeria. This result is in support of the assertion that constant power supply will provide facility for cheaper production. If constant supply of electricity is made available to industries, this can attract foreign investors easily and increase production thus making supply available at lesser time, which therefore leads to higher economic growth. However, the result concurs with the study of Amadi and Alolote (2020).

The result also revealed that government spending on transport and communication had a negative but significant impact on economic growth in Nigeria against aprior expectation. The result suggests that a unit increase in government spending on transport and communication will cause real domestic product to fall by 0.194119 units. One plausible reason for the observed result could be that funds allocated to this sector were misappropriated or embezzled by government officials and political appointees. This finding aligns with the submissions of Osundina *et al*. (2014); Nworji and Oluwalaiye (2012); Charles *et al*. (2018); Amassoma *et al.* (2011); Fasoranti (2012) but disagrees with the submission of Sahoo et al. (2010); Ebuh *et al*. (2019); Abu and Abdulhai (2010); Amadi and Alolote (2020).

The estimated model further established a long run negative but significant impact between employment rate and economic growth in Nigeria. This indicates that a unit increase in employment rate causes Nigeria's real gross domestic product to fall by 1.608974 units. The negative impact of employment rate on economic growth is not in line with the aprior expectation. According to economic theory, an increase in employment rate would lead to increase in productivity and output but the result of the employment rate showed otherwise.

4.4. Results of the Short-Run Dynamic Model

Table 4: Estimated Short-Run Error Correction Model Results

Dependent variable: Log(RGDP)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(LEMP)	0.877584	0.488140	1.797812***	0.0974
D(LEMP(-1)	0.471830	0.504585	0.935086	0.3682
D(LEMP(-2)	0.489042	0.415729	1.176347	0.2623
D(LGEXTC)	0.071397	0.032619	2.188773**	0.0491
D(LGEXTC(-1)	-0.037572	0.030610	-1.227423	0.2432
D(LGEXTC(-2)	0.030608	0.033437	0.9155390	0.3780

D(LGEXTC(-3)	-0.107425	0.032561	-3299184*	0.0064
D(LGEXP)	0.078446	0.170152	0.461036	0.6530
D(LGEXP(-1)	0.209139	0.217144	0.963134	0.3545
D(LGEXP(-2)	0.498298	0.156373	3.186592*	0.0078
ECMt-1	-0.720812	0.187936	-3.835410*	0.0024
ECM= LRGDP – 1.6090*LEMP + 0.1941*LGEXTC + 0.0699*LGEXP + 17.7962C				

Source: Summary of result compiled by author (2021) using E-Views 9. Note *, ** and *** denotes significance at 1%, 5% and 10% respectively.

The results of the short-run dynamic estimates of the impact of infrastructure investment on economic growth in Nigeria are displayed in Table 4 above. The estimate obtained from the table above for the short-run situation indicates that the error correction estimate is properly signed and significant at 1% level. The coefficient of the error correction mechanism (ECM) is (-0.7208) and its probability value is (0.0024). This is in line with the result of co-integration test that there exist a long-run relationship between infrastructure investment as measured by; government expenditure on power (electricity), government expenditure on transport and communication, employment rate and real gross domestic product in Nigeria and highly significant too. Its coefficient of 0.7208 indicates that 72.08% of the discrepancies between long-run and short-run equilibrium is corrected each year.

Also, it can be deduced from the table that employment rate had a positive and significant impact on economic growth in Nigeria in the current year. Also, the coefficients of employment rate were positive and insignificant in the first and second lag. These results indicate that past values of employment rate have a positive impact on current level of economic growth in Nigeria contrary to the long-run equation. The result means that if employment rate is increased by one percent, economic growth would increase by 0.47 percent and 0.48 percent. Hence, employment rate contributes to economic growth in the short-run.

Furthermore, government spending on transport and communication had a positive and insignificant impact on economic growth contrary to the long-run equation. The result means that a percentage increase in government spending on transport and communication would yield an infinitesimal rise of 0.07 percent on economic growth. However, government expenditure on transport and communication had a negative and positive but insignificant impact on economic growth in the first and second lags respectively whereas the coefficient of the LGEXTC was negative and significant in the third lag. Also, government spending on power had a positive and insignificant impact on economic growth of Nigeria both in the current year and first lag. The result suggests that government spending on power does contribute to economic growth in Nigeria in the short-run which is consistent with the results of the long-run equation. The result indicates that a percentage increase in government spending on power would increase real GDP by 0.08 percent and 0.21 percent in the current year and first lag respectively.

Table 5: Pairwise Granger Causality Test

Direction of causality	F-stat	P-values	Decision
GEXP ← RGDP RGDP → GEXP	0.04 5.44	0.96 0.01	Accepted Rejected
GEXTC ← RGDP RGDP ← GEXTC	2.26 1.59	0.13 0.22	Accepted Accepted
EMP ← RGDP RGDP ← EMP	0.74 1.63	0.48 0.22	Accepted Accepted
GEXTC ← GEXP GEXP ← GEXTC	1.11 0.99	0.35 0.38	Accepted Accepted
EMP ← GEXP GEXP ← EMP	1.56 2.62	0.23 0.09	Accepted Accepted
EMP → GEXTC GEXTC ← EMP	3.81 2.84	0.04 0.08	Rejected Accepted

Source: Authors Compilation, (2021) using E-Views 9. Note: The arrow shows the direction of causality.

The results in table 2 shows that at 5% level of significance, RGDP is found to granger cause GEXP with no reverse causality from GEXP to RGDP (no feedback). This implies that there is a uni-directional causality running from RGDP to GEXP without a feedback. Similarly, a uni-directional causality running from EMP to GEXTC with no reverse causality from GEXTC to EMP was found. But there is no causality between GEXTC and RGDP and vice versa; EMP and RGDP and vice versa; GEXTC and GEXP and vice versa; EMP and GEXP and vice versa.

4.5. Post Diagnostic Test Results

Table 7: Post Diagnostic Results for ARDL Model

Test	Test Statistic	P-value	Null hypothesis	Decision
Jarque-Bera normality test	2.991838	0.224043	H_o: The error terms are normally distributed.	Cannot reject H_o
Heteroscedasticity Test	2.155190	0.0949	H_o: No homoscedasticity	Cannot reject H_o
Ramsey RESET test	0.728603	0.4115	H_o: Correctly specified	Cannot reject H_o
Breusch-Godfrey LM test	3.171907	0.0857	H_o: No serial correlation	Cannot reject H_o

The post diagnostic tests results for the ARDL model in table 7 above shows that the model passed all the tests conducted. Under the Jarque-Bera normality test, a probability value of 0.224043 was greater than the proposed 0.05% level of significance. As a result, the null hypothesis of normality is accepted which suggests that the error terms are normally distributed at 5% level of significance. The result of the ARCH test showed that there was no heteroscedasticity in our model. The result shows a probability value of 0.1532 which is greater than 0.05 indicating the acceptance of the null hypothesis. Hence, there is no presence of heteroscedasticity in the model. Again, it was observed that the probability value of 0.4115 against the Ramsey Regression Equation Specification Error Test (RESET) test was greater than the proposed 5% level of significance indicating the acceptance of the null hypothesis that the model was correctly specified. This suggests that our model does not suffer from specification error and hence, has no wrong functional form. The serial correlation of the residuals was tested through the Breusch-Godfrey LM test. It was observed that the probability value of 0.0857 exceeds the 0.05% level of significance. Hence, we accept H_o and conclude that there was no serial correlation in our model.

V. CONCLUSION

In this study, thorough examination of the long-run and short-run relationship between government expenditure on economic infrastructures (power, transport and communication) and economic growth with one macroeconomic variable (employment rate) in Nigeria using data obtained from CBN statistical bulletin (2019) for the period of 1989 to 2019. The causal links between the pairs of variables of interest were established using Granger Causality test. The Augmented Dickey Fuller unit root test showed that the variable (LGEXTC) was integrated at the level 1(0) whereas others (LRGDP, LEMP, LGEXP) were integrated at the first difference 1(1). The ARDL result revealed that there exist a long-run relationship between government spending on infrastructure and economic growth in Nigeria. The result showed that government spending on transport and communication does not contribute to economic growth in Nigeria in the long-run. This result is very informative as it clearly shows the deterioration in our transport and communication infrastructure, which suggests that expenditure in the aforementioned infrastructure, has not yielded positive results over time.

The study also shows that government spending on power does contribute to economic growth in Nigeria both in the long-run and short-run. Hence, the claim that infrastructure services are essential rails which the wheels of economic progress can proceed with sustained speed is supported by this finding. Without a strong and viable infrastructure, it is difficult to achieve rapid and sustained growth of the 7 to 8 percent. However, employment rate does not contribute to economic growth in Nigeria in the long-run but in the short-run, it does contribute to economic growth in Nigeria at the first and second lags. The results further provide evidence of uni-directional causality running from RGDP to GEXP and EMP to GEXTC at 5% level of significance. On this note, there is no evidence to support the existence of causality between the remaining pairs of variable.

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